Electricity and Life

The Construction of High-Frequency Apparatus for Medical and Lecture Use.

By FREDERICK FINCH STRONG, M. D.
Lecturer on Electro-therapeutics, Tufts Medical School, Boston

(Second Article)

IN the March number of THE ELECTRICAL EXPERIMENTER the author pointed out that high-frequency currents, when properly tuned, acted as "Vital Boosters," increasing all the functions of the body and helping it to resist and throw off disease. This vitalizing effect is not due to the mere liberation of heat in the tissues, for it is produced by the very high-voltage ("Tesla") currents as well as by the heavy amperage ("D'Arsonval") currents from which the thermic effects are usually obtained.

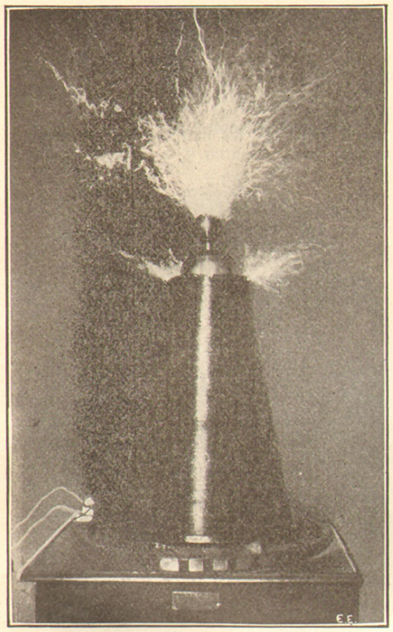


Fig. 1. View of the Strong Conical Oudin High Frequency Coil Delivering a Veritable Tree of Sparks Several Feet in Length.

When the writer demonstrated the first therapeutic Tesla Coil and the first Vacuum Electrode—(in 1896 before a Boston Medical Society)—and suggested that this method was destined to come into general use as a vitalizing agent, he was laughed at by his colleagues; yet to-day there is scarcely a well equipt physician's office in this country or in Europe that does not contain some form of therapeutic high-frequency apparatus. Even the barber-shops of the present time have their small "Violet Ray" outfits; and these are not by any means "fakes" for they produce real results, such as the relief of headache, neuralgia, skin diseases, et cetera.

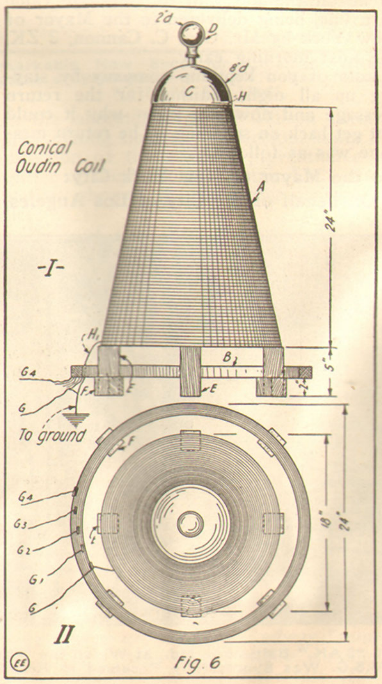
Unlike other forms of electricity, these currents may be administered to patients with perfect safety. In twenty years' experience in electro-therapeutics the author has never known of harmful results from the use of Tesla Currents applied thru a vacuum electrode. The heavy amperage ("D'Arsonval") currents, owing to their deep thermic effects, should be used only under the direction of a physician. The writer is a firm believer in the use of Tesla currents in the home—if each member of the family could receive ten-minute daily treatments from a small high-frequency apparatus, the general standard of health would be greatly increased. This has been demonstrated in hundreds of cases.

The author has interviewed a number of the more prominent authorities on medical electricity and they agree as to the vitalizing effects resulting from daily high frequency treatment.

Anyone who possesses a ¼ or ½ K.W. wireless transformer, operating on 110 volt, 60 cycle A.C., can easily construct an efficient high-frequency outfit for medical or lecture use. The complete equipment includes a .01 microfarad glass plate condenser, Tesla coil, inductance, spark gap and electrodes.

The Tesla coil is made as follows: (Fig. 3) On a paper mailing tube 2½" diam. and 14" long wind 480 turns of No. 34 D.C.C. copper magnet wire. Set up the tube in the lathe, apply a coat of orange shellac, spin on the wire, apply a second coat of shellac and allow to dry thoroly. The winding occupies twelve inches, leaving a margin of one inch on each end of the tube. Leads of light auto (ignition) cable are soldered to the ends of the winding. A strip of waxed, corrugated paper M, 5" wide is wrapt around the center of the secondary tube and on this is wound the primary, consisting of four turns of heavy high tension auto cable, and thoroly secured by tape; at least a foot of cable should project from each end of the winding to form the primary leads. Place the coil in a wax tight box made without nails and embed it in a mixture of four parts rosin and one part beeswax. It is safer to boil the coil for an hour in the insulating mixture before placing it in the box. Coils made in this way by the writer are still giving good service after fifteen years of use.

The greatest source of trouble in a medical high-frequency outfit is the spark gap; the one described below is the outcome of many years experiment. If properly made it will run daily for months without deterioration. The spark takes place between two pieces of brass rod 1¼" diam. and 3¾" long, turned and tapt as shown. The sparking surfaces are turned in annular grooves with a 60 degree tool. If your lathe has an automatic cross-feed you may set it to twenty turns to the inch, and turn a spiral groove instead of the annular rings. After finishing, the brass pieces are *heavily silver plated* and mounted in the usual manner as shown. (Fig. 4.) For currents over ¼ K.W., a plate of silver should be soldered to the brass before turning the grooves. This gap will also give greater efficiency in wireless work as compared with the usual stationary gap.



Details Are Given in This Article for Constructing a Reliable and Powerful Oudin or Tesla High Frequency Coil, Suitable for Physicians' Use. This Type of Coil is the Most Efficient Ever Designed.

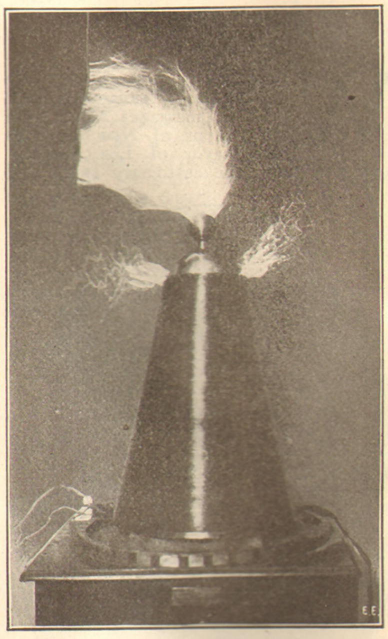


Fig. 2. Another View of the Strong High Frequency Coil Producing a Perfect Sheet of Flaming Sparks to a Grounded Conductor. The Exciting Energy Is but 1 Kilowatt.

The connections for the various parts of the apparatus are shown in Fig. 5. An important feature is the use of an external inductance or tuning coil "d" in series with the Tesla coil. It consists of 32 turns of No. 8 bare copper wire, wound on a frame 8" diam., with ¼" between turns. Edgewise wound flat copper strip is better but more expensive. (d Fig. 8.) This coil when used in series with the Tesla primary enables us to tune the oscillating system in perfect resonance when the capacity of the patient's body is added to the Tesla terminal. Effects are produced which are impossible with any other method. The beautiful *High-frequency Effluve* or brush-discharge, so valuable in treating pulmonary diseases, and which so few modern high-frequency machines can produce, is obtainable by the use of this series inductance. It may also be used, by short-circuiting the Tesla primary, as an auto-transformer from which may be derived heavy "D'Arsonval" and "Diathermic" currents as described in the next article of this series.

For stage demonstration and public lecture work the writer employs a large high-frequency resonator which produces a tree-

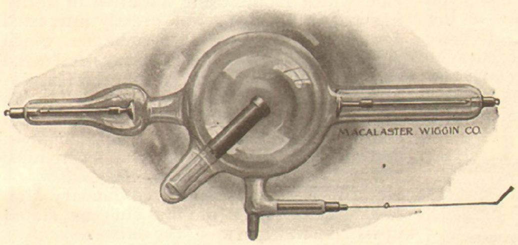
(Continued on page 59)

X-Ray Tubes for High Frequency Coils

By Dr. FREDERICK FINCH STRONG

Lecturer on Electro-therapeutics, Tufts Medical School, Boston

IN all the history of scientific achievement there has been perhaps no discovery of such a startling and revolutionary character as that of the X-Ray. The *Electron theory,* which forms the basis of the chemistry and physics of our New Age has been formulated almost entirely from deduction made possible by the work of Roentgen and the Curies.



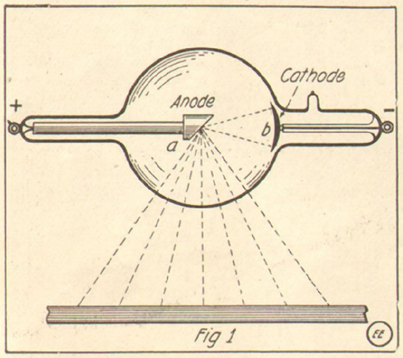
Standard Form of Single-Focus High Frequency X-Ray Tube. The First Powerful X-Ray Tubes Were Excited By a High Frequency Oscillator.

If we review the history of these discoveries we find that they have resulted from long series of researches dealing with the phenomena of electrical discharges in partial vacua.

The air pump was invented in 1650 by Otto von Guericke; by its use Sir W. Snow Harris, in 1834 was able to show that the spark-length of a given electrical machine increases in inverse ratio to the pressure of the gas thru which it passes. His tubes were exhausted to about one five-hundredth of an atmosphere, and the dischage took the form of a pencil of violet-pink light.

Geissler, in 1838, experimented with discharges in low vacua, and invented the beautiful tubes which bear his name. By improving the air-pump, he was able to withdraw all but one ten-thousandth of the original air from the glass tube, and change the color of the glow, in the electrified space from violet-pink to a pure white.

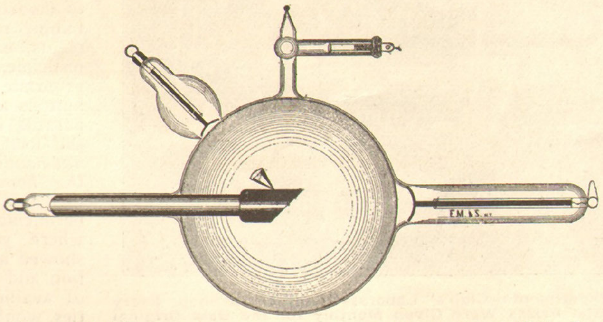
The invention of the mercury air-pump by Sprengel in 1865, made it possible for Sir William Crookes in 1878, to study electrical discharges in rarefied gases with pressures as low as *one one-millionth* of an atmosphere. He gave to the world the "Crookes tube," with which Lenard in 1894, proved the existence of the "Cathode rays," and from which in 1895, Roentgen accidentally discovered a new form of emitted energy which he tentatively called the "X-Ray."



The Simple X-Ray Tube Contains an Anode or Target "a" and an Aluminum Cathode "b." The Cathodic Electron Bombardment of Target "a" Causes X-Rays to be Produced At Right Angles or Downward As Shown.

We all recall the circumstances of this discovery. Roentgen was experimenting with a Crookes tube enveloped in an opaque cover, when he noticed a bright glow on a nearby card, coated with Platinum-Barium-Cyanid. The glow continued even when the uncoated surface of the card was presented to the tube, and further experiment showed that the interposition of the experimenter's hand between the covered tube and the fluorescent screen would cause a shadow-picture of the bones to appear upon the glowing surface.

The publication of Roentgen's discovery led investigators in all parts of the world to study the new phenomena. Static machines and Ruhmkorff induction coils were at first employed to excite the Crookes tubes; but the intensity of the resulting X-rays was not very great. In those days an induction coil giving a four-inch spark was regarded as exceedingly powerful. We know now that such an apparatus is entirely inadequate to the production of X-rays for any practical purpose.



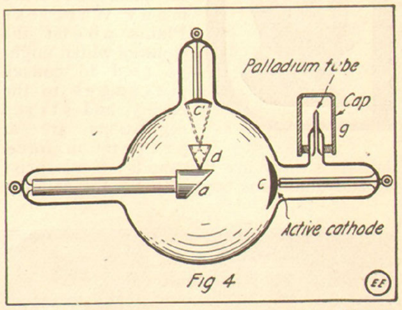
Commercial Form of a Second Type of Single-Focus High Frequency X-Ray Tube Shown Sectionally in Fig. 4. These Tubes Are Adapted to High Power Tesla or Oudin Coils.

Tesla and Elihu Thompson advocated high-frequency currents for X-ray generation, and in 1896 the Knott Apparatus Company of Boston designed the first practical commercial X-ray machine. It consisted of an open-core transformer, glass-plate condenser and Tesla coil, immersed in oil, and a rotary spark-gap not unlike those now used in Radio-telegraphy.

A few months later, the writer made the first practical high-frequency apparatus having solid insulation instead of oil, and suitable for therapeutic as well as X-ray work. The many types of high-frequency machines that are now made for physicians' use are but variations and improvements of this original apparatus.

At the present time the professional Roentgenologist uses almost exclusively powerful apparatus of the high-tension transformer type; the high-voltage, low-frequency, alternating current being rectified by a high-tension commutator operated by a synchronous motor. With such an apparatus and suitable X-ray tubes, a skiagram of the adult thorax or abdomen may be made in the *fraction of a second.*

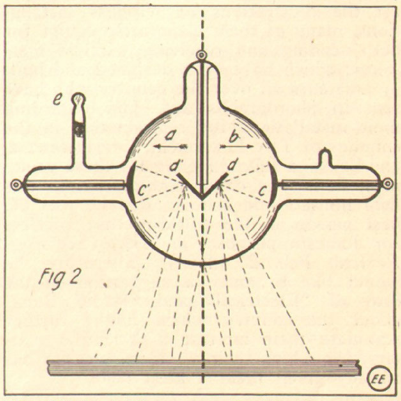
For the general practitioner, the dentist and the amateur experimenter, however, the high-frequency apparatus is still the most convenient and inexpensive device for exciting X-ray tubes, and produces results quite adequate to their respective needs.



Special Form of X-Ray Tube of the Single-Focus Type, Fitted With Palladium Vacuum Regulator and Focussing Mirror "C'", Also Copper Cone "d," for Dissipating Auxiliary Cathode Stream.

The construction of an X-ray tube is familiar to all:—in its simplest form it consists of a Crookes tube (as shown in Fig. 1), containing an anode or target (a), faced with platinum or tungsten, and a concave aluminum cathode (b). A high-voltage, unidirectional current flowing thru the tube causes streams of electrons to pass from the cathode to the target, which is set at an angle of forty-five degrees to the axis of the tube. The electronic stream ("Cathode rays"), is reflected at right angles and part of the energy is transformed into X-rays, which emerge from the glass in a divergent cone, as shown. Such a tube is not suited for use with alternating or oscillating currents, as a double set of rays would be produced; this would tend to melt the aluminum cathode and cause the absorption of the residual gas in the tube so that it would soon be too "hard" to use.

This led Elihu Thompson, in 1896, to invent his "double-focus tube"; the construction and operation of the Thompson double-focus tube is shown in Fig. 2.



The Original Thompson Double-Focus High Frequency X-Ray Tube Which Really Comprised Two Distinct Bulb Elements.

(*Continued on page* 328)